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a position or a direction of said effecting end with respect to a final rotational axis of said movable arm, said method comprising the steps of:

(a) arranging the workpiece so that a central axis of the workpiece is aligned with the final rotational axis of said movable arm; and

(b) rotating said final rotational axis to perform machining on the workpiece.

REMARKS

In accordance with the foregoing, claims 3, 10 and 11 have been amended. No new matter is being presented, and approval and entry are respectfully requested.

Claims 1 through 16 are pending and under consideration.

OBJECTIONS TO THE DRAWINGS:

In the Office Action, at page 2, the drawings were objected to. In view of the accompanying separate Letter to the Examiner Requesting Approval of Changes to the Drawings, correction to FIG. 3 has been requested. Further, the numbering of the "nozzle" as stated on page 7 has been corrected in the specification section of this amendment. Therefore, the outstanding drawing objections should be resolved.

Reconsideration and withdrawal of the outstanding objections to the drawings are respectfully requested. Corrected formal drawings shall be filed upon issuance of a Notice of Allowance.

CHANGES TO THE SPECIFICATION:

The specification has been reviewed in response to this Office Action. Changes have been made to the specification only to place it in preferred and better U.S. form for issuance and to resolve the Examiner's objections raised in the Office Action. No new matter has been added.

REJECTION UNDER 35 U.S.C. §112:

In the Office Action, at page 3, claim 10 was rejected under 35 U.S.C. §112, second paragraph, for the reasons set forth therein.

Claim 10 has been amended to further limit the method claim 9 from which it depends. Accordingly, reconsideration and withdrawal of this rejection is respectfully requested.

REJECTION UNDER 35 U.S.C. §102:

Rejection of claims 1 and 2

In the Office Action, at page 3, claims 1-2 were rejected under 35 U.S.C. §102 as being anticipated by Bannister. This rejection is traversed in view of the following arguments.

The Examiner asserts that the moveable arm including a plurality of links as disclosed in Bannister further discloses a "tooling unit 14 having a effecting end biased with respect to a final rotational axis 23 and is directed to the final rotational axis." Further, the Examiner asserts that Bannister discloses "a wrist 19 and providing the final rotational axis at the wrist."

Contrary to the assertions made by the Examiner, the moveable arm in Bannister has several housing links, i.e., 21, 25 and 27, none of which are connected by joints, but instead are connected by rolling axes such as at 26, 22 and 19. Each of these rolling axes provides for limited movement of a housing link connected thereto. More specifically, the housing link 25 is limited to rotating at 360 degrees with respect to the axis of housing 21, while housing 27 is limited to rotating at 360 degrees with respect to axis of housing 25, each rotating about the axis of the housing from which they are linked and extend therefrom. Further, the laser marker galvanized head 14 and collimator 13 combinational unit, although mounted on the distal end of the arm combination 21, 25 and 27, does not have "an effecting end biased with respect to a final rotational axis of said moveable arm and directed to said final rotational axis" as recited in independent claim 1 of Applicant's invention. Bannister does not disclose these features since the final rotational axis of the system in Bannister is located at 22 (this being the end of the arm unit and rotation occurs at this axis), and the galvanized head and collimator combinational unit is not biased with respect to this rotational axis, but is limited to rotating at 360 degrees within the rotational axis. Further, the effecting end of the galvanized head and collimator unit (if assuming it to be a tooling unit as assert by the Examiner) is not "directed to said final rotational axis,"since it protrudes out of and away from the final rotational axis of the moveable arm. Accordingly, Bannister does not anticipate claim 1 since it does not teach or suggest the features recited therein.

For at least the above reasons, Applicant respectfully submits that independent claim 1, and claim 2 which depends therefrom, are allowable over Bannister. Accordingly, withdrawal of this rejection is respectfully requested.

Rejection of claims 3 through 8

In the Office Action, at page 4, claims 3-8 were rejected under 35 U.S.C. §102 as being anticipated by Roder. This rejection is traversed in view of the following arguments.

The Examiner asserts that Roder discloses, in figure 1, a robot system having a movable arm with a plurality of links X, Y, Z. The Examiner further asserts that a the Roder system discloses "a tooling unit (46, 15, 16, figure 11) mounted on a distal end of the moveable arm and having an effecting end (15, figure 7) and a variable axis (11, figure 11) for varying a position or direction of the effecting end with respect to a final rotational axis 4 of the moveable arm."

Contrary to the assertions made by the Examiner, figure 1 of Roder illustrates a coordinate guidance machine 2 which guides a laser light by guidance members 24 and 25 movable in the X, Y, and Z coordinate directions. There are no X, Y and Z links, and the guidance members 24 and 25 do not constitute "a movable arm including a plurality of links connected by joints" as recited in independent claims 3 and 8 of Applicant's invention. The guidance members 24 and 25 guide the laser beam by moving a mirror 19 and telescoping member 3 in the different coordinate directions, and therefor there would be no purpose for connecting members 24 and 25 with joints. However, the telescopic installation 3 which extends from the machine 2 does act as a moveable arm with the aid of several joints 11, 12

and 14, as illustrated in figure 11. Accordingly, the system by Roder does not teach or suggest a robot system comprising both "a moveable arm including a plurality of links connected by joints" together with either a) "a tooling unit on a distal end of said movable arm and having an effecting end and a variable axis varying a position or a direction of said effecting end with respect to a final rotational axis of said movable arm" as recited in independent claim 3, or b) "a tooling unit mounted on a distal end of said movable arm and having an additional rotation axis biased with respect to a final rotational axis of said movable arm and an effecting end biased with respect to said additional rotational axis and directed to said additional rotation axis" as recited in independent claim 8, of Applicant's invention.

In Roder, the system guides a movable arm, including the telescopic installation 3 and its additional telescopic extensions (i.e., 49, 16, etc. in figure 11). Each of the telescopic extensions extending off of installation 3 is movable by way of joints (5, 12, etc.) in order to direct the laser to the desired spot on a workpiece to be effected, together with the movement of member 24 within the machine 2. This system therefore teaches away from the present invention in that it requires the movement of arms and joints in order to position the laser beam at its desired spot. Further, in cutting circles or other shapes into the workpiece, the movement of the member 24 also is required (i.e., in the Y-axis and X-axis direction), as disclosed in column 11, and illustrated in figure 5.

Conversely, the tool unit of the present invention provides, among other features, the ability to move an effecting end with respect to the final rotational axis of the movable arm while acting on a workpiece in order to avoid having to move the joints and links of a movable

arm during the cutting process. This novel feature of Applicant's invention prevents, among other things, loss of accuracy of a machined face due to vibrations caused by movement of several links and joints of the robot, as disclosed on page 23, lines 1-8 of Applicant's specification. Further, the tooling unit of the present invention can be biased with respect to the final rotation axis of the movable arm such that it can perform machining to form a hole or saddle shape cut on a pipe shaped workpiece with accuracy, while the joints of the movable arm remain stationary, also as disclosed at page 23, and illustrated in Figs. 3-5.

For at least the reasons stated above, Applicant respectfully submits that independent claims 3 and 8 are allowable over Roder, and accordingly, withdrawal of this rejection is earnestly solicited.

For at least the reason that claims 4-7 depend from allowable independent claim 3, Applicant respectfully submits that these claims are also allowable over Roder. Further , Applicant respectfully submits that claims 4-7 are allowable for the additional reasons that in Roder, the linear axes 6 and 17 (Figs. 7 and 11) and the variable axes 11, 12 and 14 are all part of a movable arm unit, contrary to the assertions made by the Examiner, and not part of "a tooling unit mounted on a distal end of said movable arm and having an effecting end and a variable end varying a position or a direction of an effecting end with respect to a final rotational axis of said movable arm" as recited in independent claim 3 and claims 4 through 7.

Accordingly, withdrawal of the rejection of these claims is respectfully requested, and allowance of claims 3 through 8 is earnestly solicited.

REJECTION UNDER 35 U.S.C. §103:

In the Office Action, at page 5, claims 9-16 were rejected under 35 U.S.C. §103 as being obvious over Roder. The reasons for the rejection are set forth in the Office Action and therefore not repeated. The rejection is traversed for the reasons stated below, and reconsideration is respectfully requested.

As pointed out above, Roder does not teach or suggest a robot system comprising "a movable arm including a plurality of links connected by joints..." together with "a tool unit mounted on a distal end of said movable arm, and having an effecting end biased with respect to a final rotational axis of said movable arm and directed to said final rotational axis" as recited in all of the claims of Applicant's invention, including independent claims 9, 11 and 16 and claims 10 and 12-15, which depend from independent claims 9 and 11 respectively. Further, as also previously pointed out by Applicant, the only movable arms that include a plurality of links connected by joints are the links 3, 46, 16, etc., which are connected by joints 11, 12, 13 and 14 (figure 11), or links 3, 49, 16 and 15 that are connected by joints 7, 9, and 10 (figure 15), both figures being pointed out in the Office Action. Accordingly, Applicant respectfully submits that independent claims 9, 11 and 16, and claims 10 and 12-15, which depend from independent claims 9 and 11 respectively, are allowable over Roder.

For at least the above reasons, withdrawal of this rejection and allowance of claims 9 through 16 are earnestly solicited

CONCLUSION:

In accordance with the foregoing, it is respectfully submitted that all outstanding objections and rejections have been overcome and/or rendered moot. And further, that all pending claims patentably distinguish over the prior art. Thus, there being no further outstanding objections or rejections, the application is submitted as being in condition for allowance which action is earnestly solicited.

If the Examiner has any remaining issues to be addressed, it is believed that prosecution can be expedited by the Examiner by contacting the undersigned attorney for a telephone interview to discuss resolution of such issues.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Please **REPLACE** the paragraph beginning at page 5, line 19, as follows:

--A system program for supporting basic functions of the robot and the robot controller is stored in ROM of the memory 102. Further, the operation program of the robot which is taught in accordance with an application, and related set data are stored in the nonvolatile memory of the memory 102. Further, RAM of the memory 102 is used for [temporarily] temporary storage of data in various calculation processings which are carried out by the CPU 101.--

Please **REPLACE** the paragraph beginning at page 6, line 5, as follows:

--Further, external input/output circuits of the input/output interface 106 are connected to sensors provided at the robot and actuators and sensors at peripheral devices, particularly to a laser oscillator 108 in relation with the invention. A tool unit having a laser nozzle is attached to a distal end of a movable aim of the robot and a laser beam emitted from the laser oscillator 108 is irradiated from a machining nozzle to a workpiece thereby cutting the workpiece.--

Please **REPLACE** the paragraph beginning at page 7, line 4, as follows:

--In performing a cutting operation at an end face of the workpiece W of a pipe shape by the robot having the tool unit 10, the robot is positioned so that the final axis 1 of the robot movable arm 100 (the rotational center axis of the robot wrist 1a) coincides with a central axis of the pipe-shaped workpiece W and the machining nozzle [3] 2 is located at a cutting position on the workpiece W. Then, a laser beam is irradiated from the machining nozzle 2 to the workpiece W, while rotating the final axis 1 of the robot movable arm 100 to thereby cut the workpiece W.--

Please **REPLACE** the paragraph beginning at page 7, line 16, as follows:

--The cutting position in the axial direction of the workpiece W (left and right direction in FIG. 2) can be selected to some degree by moving the position of the robot wrist la in the left and the right direction in FIG. 2. However, there is [limited] <u>limit to the</u> a diameter of the workpiece W which can be cut only by rotating the final axis 1 of the robot movable arm by using the tool unit 10. With respect to a pipe having a radius larger than a distance between the rotational center axis of the tool unit 10 (the final rotational axis of the robot movable arm) and the distal end of the machining nozzle 2, that is, larger than a shifting or biasing amount of the machining nozzle, the workpiece cannot be cut by only rotating the final axis 1 of the robot movable arm. In this case, the machining operation must be carried out by totally driving a 1 of the movable area of the robot.--

Please **REPLACE** the paragraph beginning at page 11, line 17, continuing at page 12, as follows:

--A tool unit 12 according to the third embodiment is constituted by an attaching portion 12a for attaching the tool unit 12 to the robot wrist 1a, [a] <u>an</u> axis 12b in an L shape extended from the attaching portion 12a in parallel with an attaching face of the robot wrist l la (perpendicular to the final axis 1 of the movable arm of the robot) and bent perpendicularly at a distal end thereof, an additional rotational axis 12c provided at a distal end of the axis 12b, a first additional variable axis 12d connected to the additional rotational axis 12c for expanding and retracting in a direction in parallel with the attaching face of the robot wrist 1a, a second variable axis 12e connected to a distal end of the first variable axis 12d for expanding and retracting in a direction perpendicular to the first additional axis 12d and the machining nozzle 2 attached to a distal end of the second additional variable axis 12e in which a direction of irradiating laser beam is directed in a direction perpendicular to the additional rotational axis 12c (the final axis 1 of the movable arm of the robot).--

Please **REPLACE** the paragraph beginning at page 12, line 5, as follows:

--When an end portion of a workpiece W of a small pipe is cut, the robot is positioned such that a central axis of the workpiece W to be cut and the rotational center axis of the additional rotational axis 12c are brought to coincide with each other and an end face of the workpiece W to be cut and an end face of the additional rotational axis l2c are opposed to each other. Further, the machining nozzle 2 is positioned at a position for cutting the workpiece W by driving the first and the second additional variable axes 12d and l2e., thereafter, the additional rotational axis 12c is rotated while irradiating <u>the</u> laser beam from the machining nozzle 2 by which the end face of the workpiece W is cut.--

Please **REPLACE** the paragraph beginning at page 12, lines 23, as follows:

--According to the third embodiment, when the workpiece W is cut, the [variable axis] <u>plurality of axes</u> of the robot [is] <u>movable arm are</u> not driven and the robot per se stays in a stationary state and holds predetermined position and posture. The machining accuracy is improved since the [variable axis of the robot] <u>plurality of axes of the movable arm are</u> is not driven.--

Please **REPLACE** the paragraph beginning at page 13, line 1, as follows:

--According to the above-described embodiments other than in the case of carrying out the machining method shown in FIG. 5, the direction of irradiating laser beam of the machining nozzle 2 is in a direction perpendicular to the peripheral face of the workpiece W and the cut face is perpendicular to the peripheral face of the workpiece W. Thus, only a section perpendicular to the central axis of the pipe-shaped workpiece W is obtained. When a pipe is cut in a saddle shape and [a cut face] <u>the</u> cut in the saddle shape is brought into contact with the peripheral face of [other] <u>another</u> pipe, as shown in FIG. 11, for carrying out welding of the saddle shape, the cut face perpendicular to the peripheral face of the pipe provides a joint state as shown in FIG. 12a to make the welding operation difficult and welding of high strength is not obtained. However, if the cut face having an arbitrary angle <u>that is</u> relative to

the surface of the pipe can be obtained, as shown in FIG. 12b, the cut face and the peripheral face of the other pipe are brought into close contact with each other and welding at the joint position becomes facilitated and solid.--

Please **REPLACE** the paragraph beginning at page 13, line 16, as follows:

--Hence, a description will be given on a fourth embodiment in which a cut face having an arbitrary angle that is relative to a peripheral face of a pipe is obtained, referring to FIG. 8.--

Please **REPLACE** the paragraph beginning at page 14, line 7, as follows:

--When operation of cutting a saddle shape is carried out on a workpiece W of a pipe shape, the robot is positioned such that the central axis of the workpiece W of a pipe shape and the final rotational axis 1 of the movable arm of the robot are brought to coincide with each other and the robot wrist 1a and an end face of the workpiece W are opposed to each other.[,] [t]The rotational axis 13c is positioned at a rotational angle to provide an angle of a cut face in starting cutting operation, [further,] while the machining nozzle 2 is positioned at a cut start position by driving the first and the second variable axes 13d and 13e. Further, in accordance with a taught program, while rotating the final axis 1 of the movable arm of the robot, in synchronism with [the] this rotation, the rotational axis 13c and the first and the second additional variable axes 13d and 13e are controlled to [drive by which] be driven such that there is carried out cutting operation providing the workpiece W with an arbitrary cut shape such as [that in] a saddle shape [cutting or forming] peripheral a hole. Further, also the fourth embodiment can also cut a workpiece which is not constituted by a single plane such as a pipe having a section in a cylindrical shape, a pipe having a section in an elliptic prism shape, or a pipe having a section in a square prism shape.--

Please **REPLACE** the paragraph beginning at page 16, line 24, continuing at page 15, as follows:

--Although the above-described fourth embodiment is restricted by a size (diameter) of the workpiece W to be machined, FIG. 9 shows a fifth embodiment alleviating the restriction- According to a tool unit 14 used in the fifth embodiment, the axis 13b according to the fourth embodiment is changed to a variable axis 14b. The fifth embodiment is provided with an attaching portion 14a for attaching the tool unit 14 to the robot wrist 1a, a first additional variable axis 14b extended from the attaching portion 14a perpendicularly to the final axis 1 of the movable arm of the robot where a distal end thereof is linearly moved, a rotary or pivoting axis 14c four angularly moving a second additional variable axis 14d relative to the first additional variable axis lob and further provided with a third additional variable axis 14e connected perpendicularly to a distal end of the second additional variable axis 14d for linearly moving its distal end and the machining nozzle 2 attached to a distal end of the third additional variable axis 14e. Each of the above-described first, second and third additional variable axes 14b, 14d and 14e is constituted by a structure in which its distal end can linearly be moved by a mechanism of converting rotational movement of a motor or a ball screw into linear movement.--

Please **REPLACE** the paragraph beginning at page 15, line 16, as follows:

--A difference between the fifth embodiment and the fourth embodiment resides in whether or not the axis 14b (13b) extending from the attaching portion 14a (13a) perpendicularly to the final axis 1 of the movable arm is linearly moved, as mentioned above. As is apparent by comparing FIG. 8 with FIG. 9, in view of a change in the diameter of the workpiece, in view of inclination of the cut face, and also in view of a degree of freedom of a distance from the end face of the workpiece to the cut position, the fifth embodiment, where one additional variable axis is increased, becomes facilitated in dealing with the machining operation.--

Please **REPLACE** the paragraph beginning at page 15, line 25, continuing at page 16, as follows:

--FIG. 10 shows a sixth embodiment of the invention. According to the sixth embodiment, there is provided a tool unit which is easy to position and hold a pipe of a machining object relative to the tool unit (relative to the robot wrist). According to the sixth embodiment, on an attaching portion 15a of a tool unit 15 for attachment to the robot wrist 1a, there is attached a boss 15z in a shape of a frustum having a center axis in coincidence with the rotational center axis of the tool unit 15 (the final rotational axis 1 of the robot movable arm), and the boss 15z is brought to be opposed to a workpiece W of a pipe like shape. Further, the boss 15z is made rotatable to a main body of the tool unit 15. The robot is positioned such that the central axis of the pipe of the workpiece W coincides with the final rotational axis 1 of the movable arm of the robot (center axis of the robot wrist 1 a, rotational center axis of the tool unit 15), the robot wrist is moved parallel along the axis to thereby press to fit the boss 15z to the pipe W of the workpiece such that the central axis of the pipe W is not deviated from the rotational axis of the tool unit 15. Further, while rotating the final axis 1[a] of the movable arm of the robot and rotating the tool emit 15, the workpiece is cut or drilled by the machining nozzle 2. When the tool unit 15 is rotated, although the boss 15z is rotated relative to the tool unit main body, the boss 15z is not rotated relative to the pipe of the workpiece W, and accordingly, while no hindrance is produced in rotating the tool unit main body 15, the pipe W is cut or a hole is formed therein such that the rotational center axis of the tool unit 15 coincides with the rotational center axis of the pipe W and therefore, high accurate machining operation can be carried out.--

Please **REPLACE** the paragraph beginning at page 14, line 24, as follows:

--Although [according to the example of the embodiment shown in] FIG. 10[,] provides an example of attaching the boss 15z to the second embodiment shown in FIG. 3 [has been shown], the boss 15z is applicable also to the tool units according to the first through the fifth embodiments mentioned above.--

Please **REPLACE** the paragraph beginning at page 23, line 1, as follows:

--According to the present invention, a workpiece of a pipe shape can be cut only by rotating a final axis of a movable arm of a robot and without driving other movable [arm] arms of the robot. Accordingly, machining operation having high machining accuracy can be carried out. Further, by providing a linear movement axis or a rotary or pivoting axis at a tool unit, the machining for forming a hole or the saddle shape cutting on a workpiece of a pipe shape an be performed. Further, it is possible to machine a pipe shaped workpiece to have a slant cut face with respect to an outer surface thereof.--

IN THE CLAIMS

Please **AMEND** the following claims:

3. **(ONCE AMENDED)** A robot system comprising:

a movable arm including a plurality of links connected by joints and controlled by a robot controller having a software processing function; and

a tool unit mounted on a distal end of said movable arm and having an effecting end and a variable axis [for] varying a position or a direction of said effecting end with respect to a final rotational axis of said movable arm.

10. **(ONCE AMENDED)** A [robot system] Method of machining a cylindrical workpiece according to claim 9, wherein said movable arm includes a wrist and said final rotational axis is provided at said wrist.

11. **(ONCE AMENDED)** A method of machining a pipe-like workpiece with a robot system comprising a movable arm including a plurality of links connected by joints and controlled by a robot controller having a software processing function, and a tool unit mounted on a distal end of said movable arm and having an effecting end and a variable axis for varying a position or a direction of said effecting end with respect to a final rotational axis of said movable arm, said method comprising the steps of:

(a) arranging the workpiece so that a central axis of the workpiece is aligned with the final rotational axis of said movable arm; and

(b) rotating said final [rotary] <u>rotational</u> axis to perform machining on the workpiece.